Observations of mobbing and other agonistic responses to the Powerful Owl *Ninox strenua*

Matthew Mo[1], David R. Waterhouse[2], Peter Hayler[3] and Antonia Hayler[3]

[1]State Veterinary Diagnostic Laboratory, NSW Department of Primary Industries, Elizabeth Macarthur Agricultural Institute, Woodbridge Road, Menangle NSW 2568, Australia. Corresponding author. Email: matthew.mo@dpi.nsw.gov.au

[2]4/1-5 Ada Street, Oatley NSW 2223, Australia.

[3]Choosypix Photography. Email: choosypix@yahoo.com.au

ABSTRACT

Mobbing is an anti-predator strategy in which prey animals, notably birds and mammals, aggravate a potential predator to either distract or drive them from the vicinity. The Powerful Owl *Ninox strenua* is a large forest owl endemic to eastern Australia that preys mainly on arboreal mammals and birds. We identified records of 30 species of birds and one mammal known to mob the Powerful Owl from scientific literature and unpublished studies. In our study in southern Sydney, Powerful Owls were most frequently mobbed by Noisy Miners *Manorina melanocephala* and Pied Currawongs *Strepera graculina*, followed by Grey Butcherbirds *Cracticus torquatus* and Australian Magpies *Cracticus tibicen*. We observed mobbing by three species of bird and one mammal that were not previously recorded as mobbing species, including agonistic responses by a Tawny Frogmouth *Podargus strigoides* and Common Brushtail Possum *Trichosurus vulpecula* during the time owls were active.

Key words: anti-predator defence, behavioural ecology

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Introduction

The anti-predator defensive strategy of mobbing occurs throughout the animal kingdom, but is most notable in birds and mammals (Stone and Trost 1991; Dugatkin and Godin 1992; Caro 2005; Clark 2005; Kirkwood and Dickie 2005; Hendrichsen *et al.* 2006; Krams *et al.* 2006). Although the term was traditionally used to describe a group of potential prey antagonising a potential predator, its definition has been broadened to include situations where a prey animal singly aggravates a potential predator, attempting to drive it away (Birkhead 1972; Ostreiher 2003). Mobbing serves to either distract predators or drive them from the vicinity (Curio 1978; McLean *et al.* 1986; Pavey and Smyth 1998).

The Powerful Owl *Ninox strenua* is endemic to Australia, where it is the largest nocturnal bird of prey (1200-1600 g; Higgins 1999). Once thought to be restricted to old-growth forests (Fleay 1968), breeding pairs have since been studied in a range of habitats, including remnants of native vegetation in urban areas (Debus and Chafer 1994; Pavey *et al.* 1994; Cooke *et al.* 2002; Olsen *et al.* 2011; McNabb *et al.* 2007; Fitzsimons and Rose 2010; Mo and Waterhouse 2015; Mo *et al.* 2015a,b). The diet of the Powerful Owl mainly consists of arboreal mammals and birds, supplemented by insects (Pavey 1995; McNabb 1996; Kavanagh 2002; Cooke *et al.* 2006; Bilney 2013a).

A large volume of scientific literature concerning the ecology of the Powerful Owl has amassed, especially in the past three decades (Higgins 1999; Bilney *et al.* 2011; Olsen *et al.* 2013), especially in Sydney and surrounding metropolitan districts (Chafer 1992; Rose 1993; Kavanagh 2004; McAllan and Larkins 2005; Bain *et al.* 2014). Despite this literature, few publications mention other animals mobbing Powerful Owls (Pavey and Smyth 1998). Here, we synthesise information regarding mobbing species of Powerful Owls identified in previous studies, and report observations of mobbing bouts recorded during our study in Sydney, as well as one agonistic response toward Powerful Owls by a Common Brushtail Possum *Trichosurus vulpecula*.

Methods

Literature review

Scientific literature was reviewed to identify species previously recorded mobbing Powerful Owls across their distribution. We adapt Pavey and Smyth's (1998) definition of mobbing as any behaviour in which an animal harasses an owl, which can either be loud vocalisations and/or conspicuous visual displays within 3 m of the owls, or direct attacks toward the owls. We also contacted fellow Powerful Owl researchers to gather information from their unpublished studies.

Field observations

Since 2012, we have carried out an observational study aimed at monitoring breeding success and habitat use in three breeding territories in the St George area, southern Sydney (Fig. 1). The territories occurred within an area of 700 ha, primarily situated in bushland remnants and

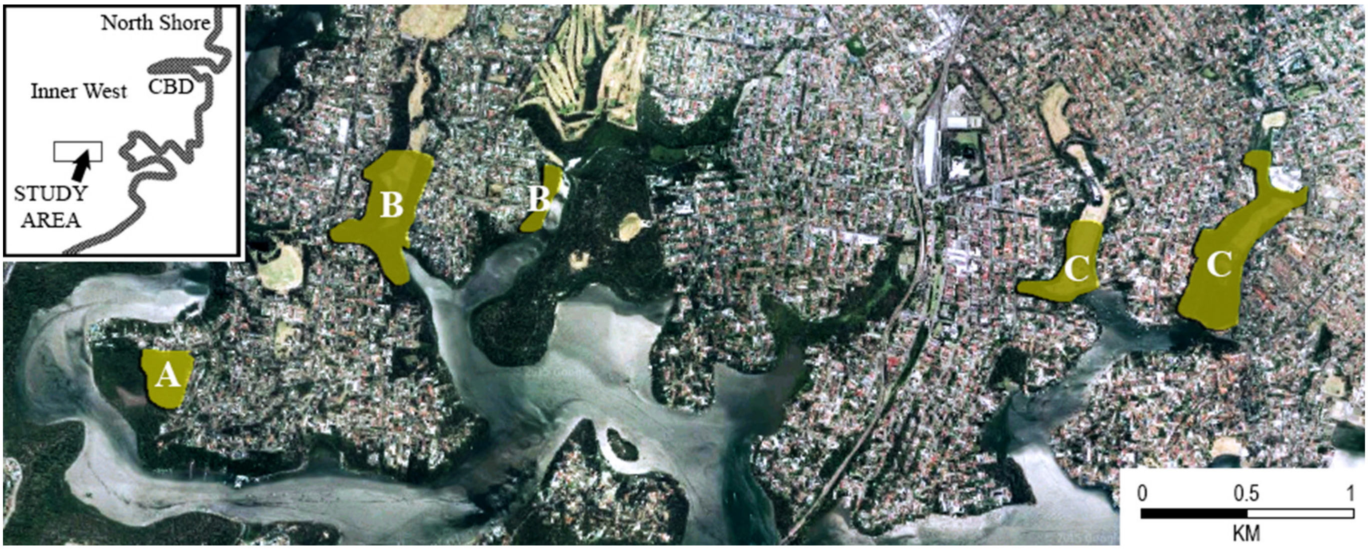

Figure 1. The locations of three breeding territories of the Powerful Owl *Ninox strenua* used in our study. Inset: the study area within the context of the Sydney Metropolitan Area.

parklands, which receive medium to high recreational visitation. More detailed description of the study area have been provided elsewhere (Mo and Waterhouse 2015; Mo *et al.* 2015a,b).

Unlike Powerful Owls studied in remote locations (e.g. Fleay 1968), our study animals were habituated to humans and not wary of observers, providing opportunities for recording behavioural notes. To date, at least 1500 observation sessions have been staged across the three breeding territories, totaling over 1800 hours of surveillance. Mostly, we observed the owls at dusk and located them at their daytime roosts, with some observations made at later hours of the night.

We consider a single mobbing bout to be any number of interactions within a single encounter between a mobbing species and an owl. A large number of these, probably over 1000, were witnessed as part of our observations. Unfortunately, the significance of these observations was not immediately realised and consequently, mobbing bouts were not recorded exhaustively in field notes as in Pavey and Smyth's (1998) work. Consequently, the exact number of mobbing bouts is not known and the frequency of agonistic interaction by each mobbing species was limited to estimates. Frequencies for each species were reported here solely to provide some insight on regularity in observations, and were not intended to be a comparative index between species.

Results

Our review identified 15 mobbing species from scientific literature, and a further 16 species from unpublished studies (Table 1). All were avian, except one (Yellow-bellied Glider *Petaurus australis*; McNabb 1994) and none exceeded the mean body mass of the Powerful Owl. The heaviest mobbing species was the Sulphur-crested Cockatoo *Cacatua galerita*, which has a mean body mass of 800 g (McNabb 1996). Nine species (29%) fell within the range of 300-550 g. Fifteen species (48%) were less than 100 g, with the smallest being the Brown Thornbill *Acanthiza pusilla* (M. Stanton, unpubl. data), which has a mean body mass of only 7 g.

Our field observations identified eight birds as mobbing species of the Powerful Owl (Table 2), as well as one agonistic response from a Common Brushtail Possum toward owls. The Noisy Miner *Manorina melanocephala* and Pied Currawong *Strepera graculina* frequently mobbed the owls, with mobbing bouts occurring in greater than 5 percent of diurnal observation sessions. Two others, the Grey Butcherbird *Cracticus torquatus* and Australian Magpie *Cracticus tibicen*, were occasional in their frequency of mobbing. All four were observed making direct physical contact with owls and mobbed both singly and in groups, except for the Grey Butcherbird, which was only recorded to mob singly. Two other species (Laughing Kookaburra *Dacelo novaeguineae* and Red Wattlebird *Anthochaera carunculata*) were observed mobbing once and two others (Rainbow Lorikeet *Trichoglossus moluccanus* and Tawny Frogmouth *Podargus strigoides*) were observed mobbing twice. Owls roosting in the mangroves (available in sites B and C) appeared to experience less mobbing than owls roosting in other habitats. Mobbing species in the mangroves were limited to Pied Currawongs and Grey Butcherbirds.

Mobbing by Noisy Miners *Manorina melanocephala*

Noisy Miners were abundant in the study area, occurring in substantial numbers in areas of open woodland, parkland and suburbia across all three breeding territories. Mobbing by this species occurred in most diurnal observation sessions where Powerful Owls were roosting in these habitats (Fig. 2; Table 2). In contrast, Noisy Miners were noticeably less common to absent in more vegetated locations such as closed canopy bushland and mangroves. Powerful Owls were not mobbed by Noisy Miners when roosting in these habitats.

Noisy Miners typically mobbed in groups of up to six individuals. On five occasions, more than 10 individuals were involved in the same mobbing bout. In groups, Noisy Miners perched around the owl(s), emitting recurrent

Table 1. Mobbing species of the Powerful Owl *Ninox strenua* identified in scientific literature and unpublished studies.

	Mean body mass (g)	Source
Sulphur-crested Cockatoo *Cacatua galerita*	800	McNabb 1996
Crimson Rosella *Platycercus elegans*	130	Olsen *et al.* 2011
Southern Boobook *Ninox novaeseelandiae*	340	McNabb 1994, 1996; Debus 1997
Laughing Kookaburra *Dacelo novaeguineae*	306	McNabb 1996; Pavey & Smyth 1998
Satin Bowerbird *Ptilonorhynchus violaceus*	204	A. Lumnitzer, unpubl. data
White-browed Scrubwren *Sericornis frontalis*	12	M. Stanton, unpubl. data
Large-billed Scrubwren *Sericornis magnirostris*	10	M. Stanton, unpubl. data
Brown Thornbill *Acanthiza pusilla*	7	M. Stanton, unpubl. data
Lewin's Honeyeater *Meliphaga lewinii*	34	A. Lumnitzer, unpubl. data
Yellow-tufted Honeyeater *Lichenostomus melanops*	22	A. Lumnitzer, unpubl. data
Bell Miner *Manorina melanophrys*	29	M. Stanton, unpubl.data
Noisy Miner *Manorina melanocephala*	59	Pavey & Smyth 1998; Göth & Maloney 2012
Crescent Honeyeater *Phylidonyris pyrrhopterus*	16	M. Stanton, unpubl. data
Blue-faced Honeyeater *Entomyzon cyanotis*	105	M. Stanton, unpubl. data
Brown-headed Honeyeater *Melithreptus brevirostris*	13	M. Stanton, unpubl. data
Noisy Friarbird *Philemon corniculatus*	117	M. Stanton, unpubl. data
Little Friarbird *Philemon citreogularis*	67	M. Stanton, unpubl. data
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	134	Pavey & Smyth 1998
Australian Magpie *Cracticus tibicen*	330	McNabb *et al.* 2007; Olsen *et al.* 2011
Grey Butcherbird *Cracticus torquatus*	75	Pavey & Smyth 1998
Pied Currawong *Strepera graculina*	321	Chafer 1992; Pavey & Smyth 1998; Olsen *et al.* 2011
Grey Currawong *Strepera versicolor*	350	McNabb 1996
Spangled Drongo *Dicrurus bracteatus*	79	Pavey & Smyth 1998
Grey Fantail *Rhipidura fuliginosa*	8	Pavey & Smyth 1998
Willie Wagtail *Rhipidura leucophrys*	20	M. Stanton, unpubl. data
Australian Raven *Corvus coronoides*	557	M. Stanton and N. Kirby, unpubl. data
Little Raven *Corvus mellori*	530	McNabb 1996; McNabb *et al.* 2007
Forest Raven *Corvus tasmanicus*	650	M. Stanton, unpubl. data
Magpie-lark *Grallina cyanoleuca*	92	J. Bundock, unpubl. data
White-winged Chough *Corcorax melanorhamphos*	360	Olsen *et al.* 2011
Yellow-bellied Glider *Petaurus australis*	600	McNabb 1994

Table 2. Mobbing species of the Powerful Owl Ninox strenua observed in southern Sydney by the authors. Frequency of mobbing: frequent (probably greater than 5% of diurnal observation sessions), occasional (probably less than 5% of diurnal observation sessions).

	Mean body mass (g)	Frequency of mobbing	No. sites	Singly/ groups	Contact recorded
Rainbow Lorikeet *Trichoglossus moluccanus*	133	Observed twice	1	G	No
Tawny Frogmouth *Podargus strigoides*	650	Observed twice	1	S	No
Laughing Kookaburra *Dacelo novaeguineae*	306	Observed once	1	S	No
Noisy Miner *Manorina melanocephala*	59	Frequent	3	S, G	Yes
Red Wattlebird *Anthochaera carunculata*	111	Observed once	1	G	No
Australian Magpie *Cracticus tibicen*	330	Occasional	2	S, G	Yes
Grey Butcherbird *Cracticus torquatus*	75	Occasional	2	S	Yes
Pied Currawong *Strepera graculina*	321	Frequent	3	S, G	Yes

weep weep calls. These mobbing bouts usually last for approximately four minutes at a time, once enduring for 16 minutes. Adult owls never showed sign of disturbance or irritation, except to stare, although some fledglings showed some signs of distress in the first few weeks of fledging. Some adult owls remained asleep throughout mobbing bouts.

Lone Noisy Miners were different in their approach to mobbing Powerful Owls. In these situations, the Noisy Miner positioned behind or side-on from the owl (Fig. 2). Their calling was also typically more intermittent than in a group situation. Sometimes the Noisy Miner flew into the back of the owl, and in some cases, successfully bumping the owl forward. We only observed Noisy Miners making physical contact with Powerful Owls when they mobbed alone. Despite physical contact, responses from the owls to these types of bouts were also minimal. Lone mobbing bouts by Noisy Miners were usually short-lived, not lasting more than 2 minutes.

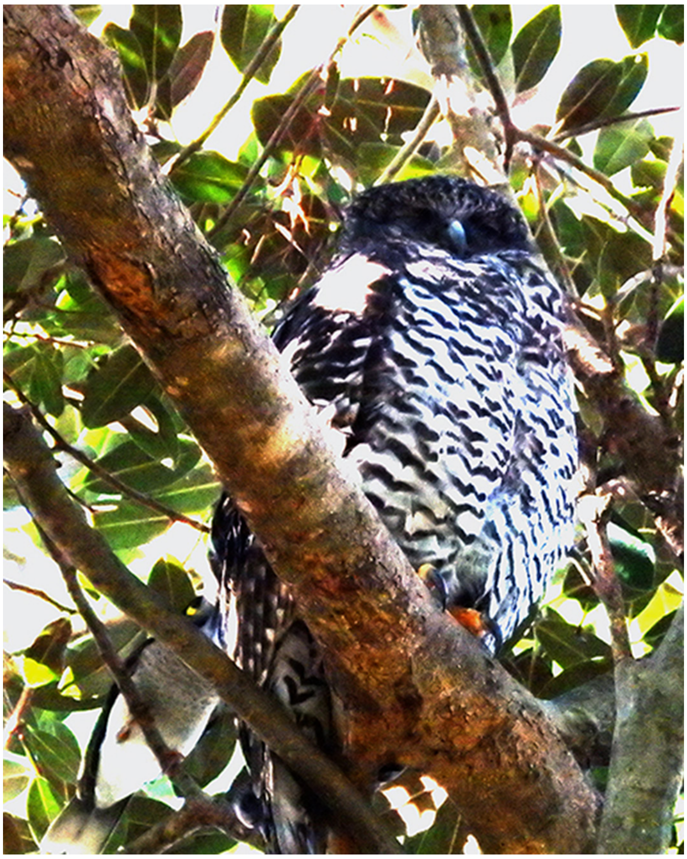

Figure 2. A male Powerful Owl *Ninox strenua* at its daytime roost being mobbed from behind by a lone Noisy Miner *Manorina melanocephala*. Photo, M. Mo.

Mobbing by Pied Currawongs *Strepera graculina*, Grey Butcherbirds *Cracticus torquatus* and Australian Magpies *Cracticus tibicen*

Lone mobbing behaviour by Pied Currawongs, Grey Butcherbirds and Australian Magpies was ostensibly similar, hence reported here collectively. These species harassed both adult Powerful Owls and fledglings during the day and at dusk. The Pied Currawong engaged in mobbing bouts frequently (Fig. 3), which took place in all three sites (Table 2). Mobbing by Grey Butcherbirds and

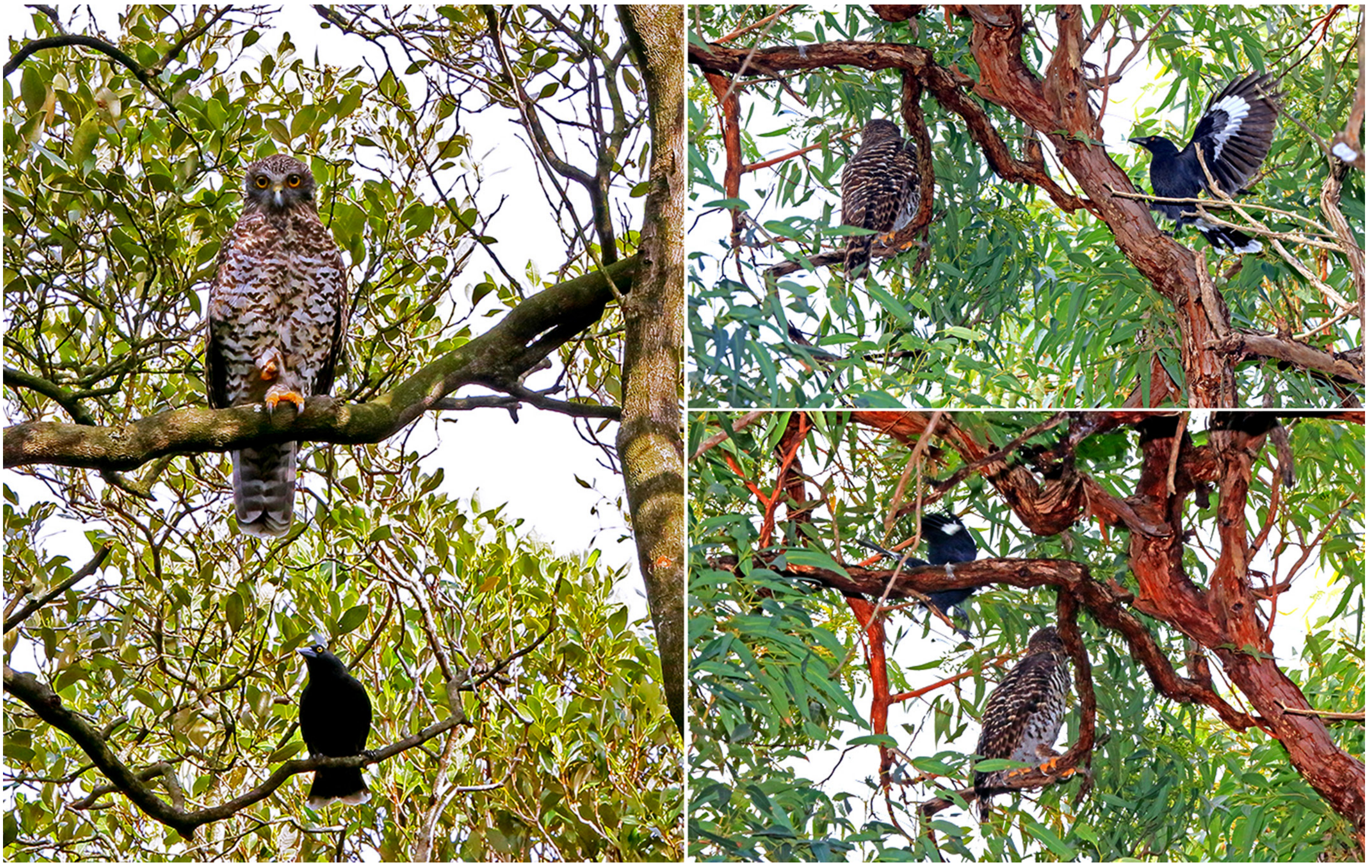

Figure 3. Pied Currawongs *Strepera graculina* in a mobbing bout focused on a pair of Powerful Owls *Ninox strenua*. Photo, P. and A. Hayler.

Australian Magpies was not as common, occurring in sites B and C, and sites A and C respectively.

Typically, these species perched on a nearby branch within 3 m of the owl(s), facing their target for between 10 seconds and up to 5 minutes. Swooping occurred from behind or above the owl, usually combined with beak-clacking or a single-note alarm call. The Pied Currawong emitted a *currah* call, whereas the Grey Butcherbird and Australian Magpie typically squawked upon swooping. These species occasionally made contact with the owls, usually targeting the back of the head (Fig. 4) or tail feathers.

Pied Currawongs also mobbed in groups, usually composed of three to ten individuals. In these mobbing bouts, currawongs often began by perching in the same tree as the owl(s) or nearby and emitting recurrent alarm calls, which sometimes gathered conspecifics to the location. On 22 August 2014, a flock of 23 currawongs amassed around two adult Powerful Owls and their two fledglings in site C. In most instances, currawongs perched at various levels around the owl(s), such that when an owl turned in response to contact or close swoops by one currawong, it was targeted almost immediately by another from a different direction.

Powerful Owls in site C annually used a nest hollow in an area of relatively low canopy cover and were subjected to daily mobbing at dusk by Pied Currawongs, Grey Butcherbirds and Australian Magpies during the nesting and early post-fledging periods of the owls. In contrast, diurnal mobbing by these species was intermittent. On some evenings, these mobbing bouts took place for up to 50 minutes and Noisy Miners were often attracted. Although owl(s) were noticeably disturbed by mixed-species mobbing bouts, it did not necessarily eliminate their hunting capability, as we observed an adult owl in site C capture a Grey-headed Flying Fox *Pteropus poliocephalus* in the midst of such an event (described by Mo *et al.* 2015b).

Pied Currawongs, Grey Butcherbirds and Australian Magpies were the only mobbing birds in the present study to successfully displace Powerful Owls from their diurnal roost perches. The usual response of owls disturbed by mobbing involved clinging to the perch by both feet (as opposed to clinging by a single foot during roosting) and outstretching the neck (Fig. 5). Adult owls were generally not alarmed until these mobbing species inflicted contact or grouped in large numbers. Once, recurrent calling by currawongs from a distance of more than 20 m alarmed one of two fledglings in site C for over 30 minutes. Intermittent trilling by fledglings was occasionally heard in response to flocking currawongs.

Mobbing by Tawny Frogmouths *Podargus strigoides*

Mobbing by the Tawny Frogmouth was observed over two consecutive dusk observation sessions in site C. In both cases, frogmouths singly made non-contact attacks on a pair of Powerful Owl fledglings.

On 8 November 2014, the two fledglings were located flying from perch to perch at 19:50 h, intermittently foliage-snatching (cf. Mo and Waterhouse 2015). An adult Tawny

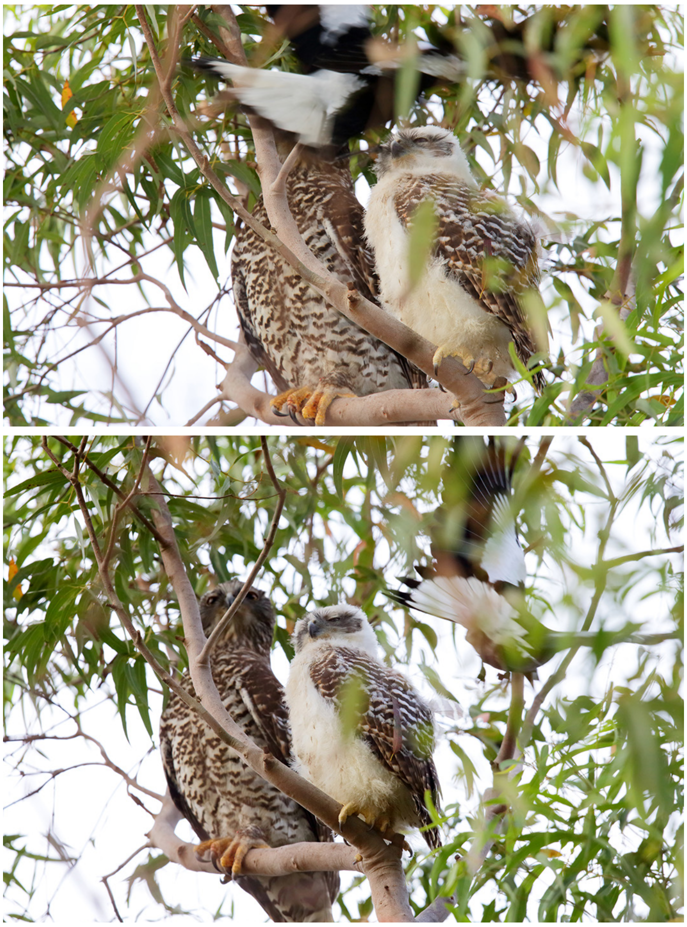

Figure 4. An Australian Magpie *Cracticus tibicen* makes contact with a Powerful Owl *Ninox strenua* fledgling during a mobbing bout. Photo, P. and A. Hayler.

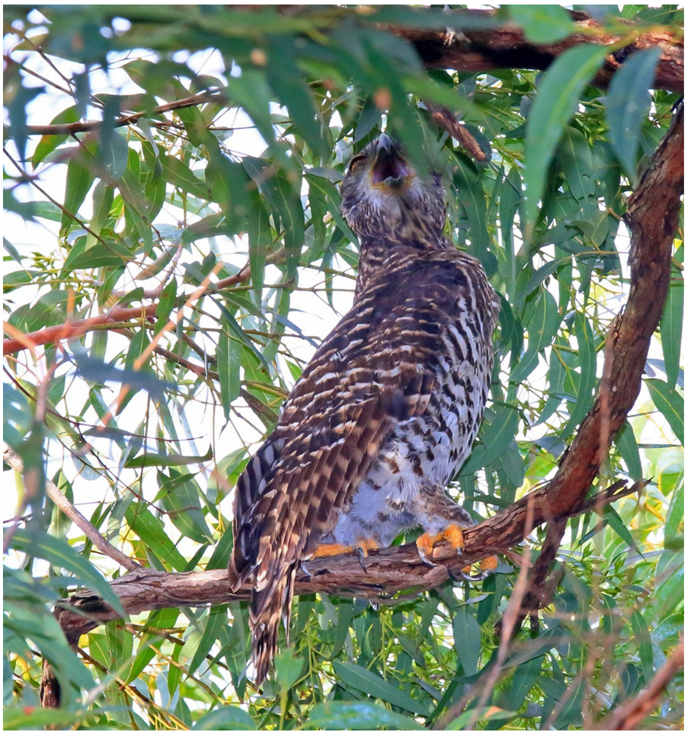

Figure 5. A Powerful Owl *Ninox strenua* responding to mobbing by a Pied Currawong *Strepera graculina*. Note, the outstretched neck and both talons perched. Photo, P. and A. Hayler.

Frogmouth flew at one fledgling from behind, emitting two loud *gwark* calls upon closing in before repeating this display with the other fledgling from above. Both times, the frogmouth came within 50 cm of them. Apart from being momentarily surprised, the fledglings' responses were minimal. The frogmouth perched 8 m away and stared at the fledglings until they flew away after 3 minutes. It then attacked one of the fledglings, emitting a single *gwark* call.

On 9 November 2014, the two fledglings returned to the site of the previous night's observations. A frogmouth flew at one of them, emitting a single *gwark* call. The owl was surprised but did not leave its perch. The entire mobbing bout occurred within seconds with the frogmouth flying quickly out of sight.

Mobbing by Red Wattlebirds *Anthochaera carunculata*

On 28 February 2015, one of the owls in site B was holding a Red Wattlebird carcass. Observations were made between 11:11 h and 12:15 h, during which six wattlebirds directed mobbing in 2- to 3-minute bursts throughout the observation session. Mobbing consisted of single *quok* alarm calls and rapid changing of perches around the owls. Occasionally, one wattlebird swooped within at least 60 cm of an owl's head.

This observation occurred after the owls were also found with Red Wattlebird carcasses on three consecutive days from 24 February to 26 February 2015. The area was frequented by an unusually large number of wattlebirds during this week, which had not occurred prior or since.

Mobbing by a Laughing Kookaburra *Dacelo novaeguineae* and Rainbow Lorikeets *Trichoglossus moluccanus*

A brief mobbing bout involving a Laughing Kookaburra was observed once at site B on 9 June 2015. A breeding pair of Powerful Owls had commenced using a nesting hollow; the female was residing in the cavity while the male roosted on a nearby branch when the mobbing occurred. At 11:07 h, two kookaburras landed on a branch above the owl and gave a series of three- to five-note cackling calls. One kookaburra swooped down within 1 m of the owl's head, beak-clacking as it closed in. It returned to its previous perch before launching a similar swoop at 11:10 h. Both times, the owl dipped its head in response. After the second swoop, the kookaburras left the vicinity.

During the time the kookaburras watched the owl, a flock of 12 Rainbow Lorikeets had amassed in an adjacent tree. They squawked continually for the 16 minutes that they were present in the vicinity. After the kookaburras departed, lorikeets swooped within 2 m above the owl one at a time. Five to seven swoops occurred per minute. The owl had settled shortly after the kookaburra's second swoop and mostly slept as the lorikeets mobbed.

On 26 June 2015, a second observation of Rainbow Lorikeets mobbing this male owl was recorded. A flock of 6 currawongs sounded alarm calls and swooped the owl at dusk, apparently attracting the lorikeets. The flock of 10 lorikeets actively occupied a branch 3 m from the owl, frequently rotating perches while screeching and squawking. The lorikeets and currawongs dispersed when the owl began to call to its mate.

Agonistic response from a Common Brushtail Possum *Trichosurus vulpecula*

During the present study, Powerful Owls and Common Brushtail Possums were observed within proximities of 10 m on eight occasions, including two passive encounters in which neither reacted to the other. In other instances, possums grunted in alarm while moving slowly away or holding their ground.

In one novel observation, an adult male possum fended off two owl fledglings that approached it. This incident was recorded on 23 October 2014 at 20:10 h and lasted 6 minutes. The owls flew into a tree, landing approximately 5 m from the possum. Given the age of the owls, it is likely that they approached the possum out of curiosity rather than attempting predation.

The possum growled while climbing across branches, then stood on its hind limbs with its forepaws held close to its chest. Both owls descended closer, prompting the possum to charge at one of them. This owl was displaced from its perch but immediately returned to swoop within 1 m of the possum before settling on a nearby branch. The possum emitted a louder growl and charged at both fledglings. The owls returned to the possum several times, but did not perform any further swoops. The possum ignored the owls for the remainder of the time they were present.

Discussion

A total of 31 mobbing species was identified from previous studies, with the present study contributing a further three species: the Rainbow Lorikeet, Tawny Frogmouth and Red Wattlebird. The majority of species were diurnal in habit (91%). Except perhaps at dusk and dawn, many diurnal birds were unlikely to witness hunting behaviour by the Powerful Owl, which is crepuscular to nocturnal (Pavey and Smyth 1998). Nevertheless, these species recognise the owl as a potential predator. Only a minority of mobbing species (39%) had actually been recorded in the Powerful Owl's diet (Debus and Chafer 1994; Pavey *et al.* 1994; Kavanagh 1997; Schulz 1997; Bilney 2013a). A large proportion of mobbing species (42%) did not exceed 100 g, of which only one was a known prey species. To date, the Noisy Miner (59 g) appears to be at the smaller limit of avian prey taken by the Powerful Owl (Pavey *et al.* 1994; M. Mo *et al.* unpubl. data). Nonetheless, it was one of the two most prolific mobbing species in the present study. Predation on the Red Wattlebird was significant, as this species has not been recorded in the diet elsewhere. In Pavey and Smyth's (1998) study, the frequency of owl predation was significantly lower for birds that engaged in mobbing.

The Tawny Frogmouth, being nocturnal, is one of few bird species that are able to mob the owls during the time when hunting would actually occur, as observed in this study. The Tawny Frogmouth has been recorded as prey (Barnard 1924; Debus and Chafer 1994; Pavey

1994; Schulz 1997; Bilney 2013a,b), and an ambush on one was reported by Chafer (1992). In the present study, the frogmouth may have been breeding nearby as a nest could easily have been concealed by private property, however whether the incidents recorded involved the same individual was not certain.

Previous studies have demonstrated the effective use of mobbing by birds to successfully displace some birds of prey, including owls (Flasskamp 1994). On the other hand, mobbing has the potential to backfire on mobbers by revealing the location of its nests and young to predators or making the mobbers themselves vulnerable to predation (Denson 1979; McLean *et al.* 1986; Tórrez *et al.* 2012). Except for moving the owls away from their home sites, the direct benefits for diurnal birds in mobbing roosting Powerful Owl are not entirely understood.

Although the Red Wattlebird may be limited in its ability to injure predators, its alarm calls have been known to attract Australian Magpies (Jurisevic and Sanderson 1994a). The Australian Magpie is well known for mobbing many species, including birds of prey (Genelly 1978; Lawrence and Gay 1991; Brown *et al.* 2000; Morgan *et al.* 2005), as are Pied Currawongs (Czechura *et al.* 1987; Burton 1993) and Grey Butcherbirds (Jurisevic and Sanderson 1994b). Both Australian Magpies and Pied Currawongs are capable of inflicting serious injuries on birds of prey (Roberts 1942; Czechura *et al.* 1987; Higgins *et al.* 2006). For at least two years, a Grey Butcherbird nested in a tree that was 18 m from the nest hollow used by Powerful Owls in site C. This close proximity may have been an important factor in the number of mobbing bouts observed for this species.

Literature on mobbing of Australian owls has mostly focused on birds (Pavey and Smyth 1998; Johnson *et al.* 2003), although McNabb (1994) also mentioned mammals as mobbing species. Our observations provided an account of a Common Brushtail Possum responding agonistically toward a pair of Powerful Owls. While this is a known prey species of the Powerful Owl (Kavanagh 2002; Cooke *et al.* 2006; Olsen *et al.* 2011; Bilney 2013a), especially in urban areas (Fitzsimmons and Rose 2010), however the situation in our observation did not fall within the definition of mobbing. The scenario is very different to observations of birds mobbing the owls in that the possum was provoked by the owls. Also, it was unlikely that the fledgling owls were approaching the possum with the intent of hunting. Alternatively, the possum may have been defending a joey close by, instead of avoiding direct predation.

Olsen and Trost (2009) reported a series of agonistic responses of Common Brushtail Possums toward a breeding pair of Southern Boobooks *Ninox novaeseelandiae*, which in turn had been mobbed by the owls. There does not appear to be any further reports of brushtail possums confronting owls elsewhere. Some authors have alluded to Powerful Owls and Common Brushtail Possums being direct competitors for tree hollows (McNabb and Greenwood 2011; Olsen *et al.* 2011).

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